Revolutionary Research . . . Relevant Results

DIRECTOR OF RESEARCH
DISCOVERY and INVENTION
...where creativity thrives

Basic & Applied Research Opportunities & Advances

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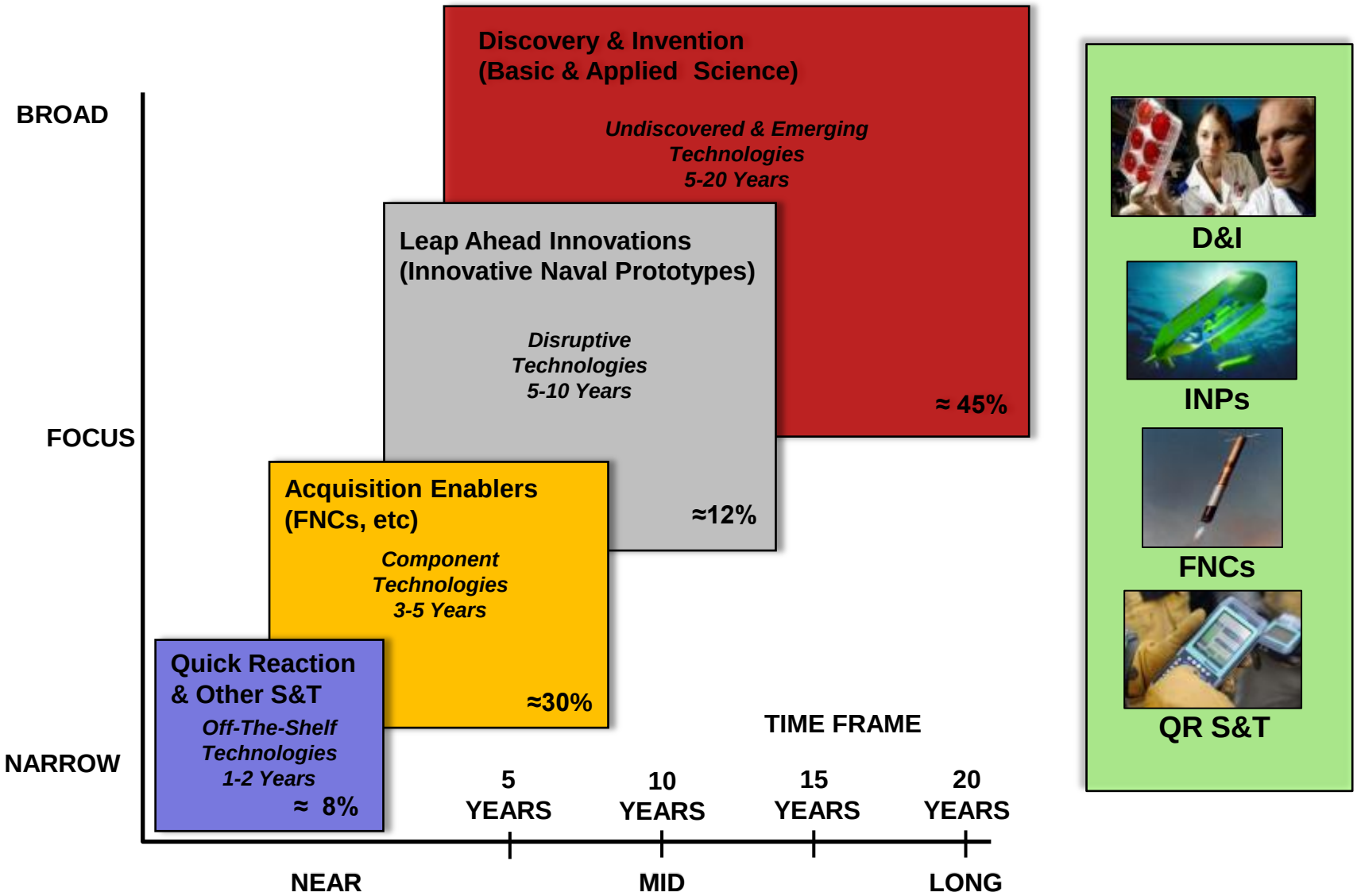
Naval S&T Strategic Plan

- Cascades from National, DoD and SECNAV/CNO/CMC Guidance
- Vetted by Fleet/Forces Stakeholders
- Approved by DoN S&T Corporate Board

S&T Plan Focus Areas:

- Assure Access to Maritime Battlespace
- Autonomy & Unmanned Systems
- Expeditionary & Irregular Warfare
- Power Projection/Integrated Defense
- Information Dominance
- Power & Energy
- Platform Design & Survivability
- Total Ownership Cost
- Warfighter Performance

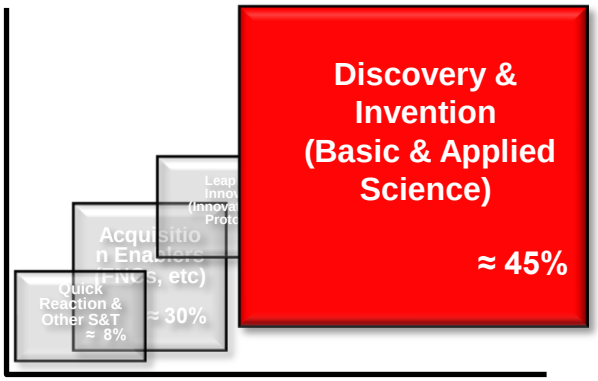
ONR S&T Portfolio Balance



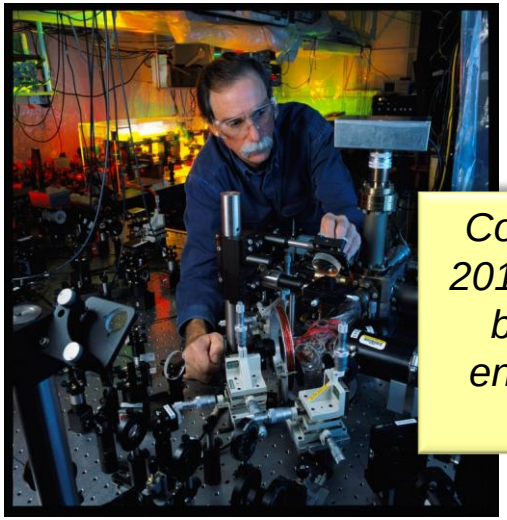
Discovery & Invention S&T

Discovery & Invention (D&I) consists of Basic Research (BA 6.1) and early Applied Research (BA 6.2). It is the essential foundation required for advanced technology

- Focused on 5-20 years out
- ≈ 45% of ONR's budget
- New investments selected through competitive process across warfare areas
- D&I budget includes:
  - ONR's core research programs
  - University Research Initiatives (MURI, DURIP, PECASE)
  - In-House Laboratory Independent Research
  - STEM



- **Diverse Portfolio**
- **Fosters Innovation**
- **Long-Term**
- **Investment in People:**
  60 ***Nobel Laureates***



Congratulations Dr. David J. Wineland! 2012 Nobel Prize in Physics "for ground-breaking experimental methods that enable measuring and manipulation of individual quantum systems."

Yesterday

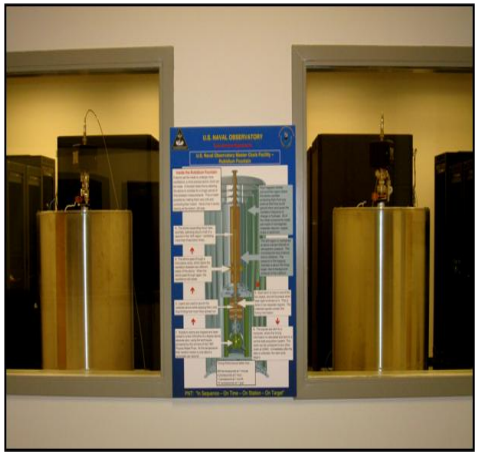
Precision Time and Timekeeping (PTT):

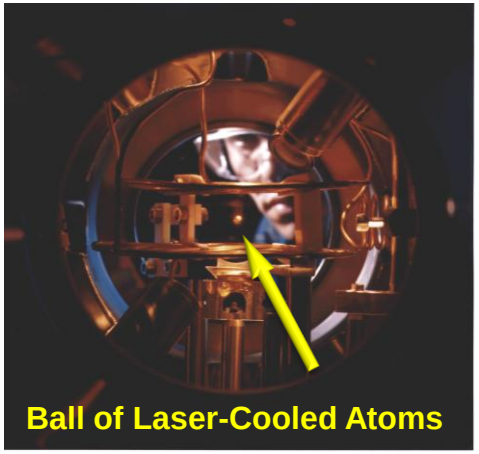
- ONR funding for basic research in atomic clocks has led to significant advances in PTT.
- The US Naval Observatory (USNO) maintains the DoD Master Clock with 60 Cs (Cesium-133) atomic clocks, 20 Hydrogen maser clocks, and two Cesium Fountain atomic clocks.
- The DoD Master Clock is a Critical National Defense Technology (MCTL Section 16).
- ONR funding sustains the Atomic Clock industrial base in U.S.

ONR research support produced:

- Four Nobel Prizes (1997, 2001, 2005, & 2012)
- Six ONR Nobel Laureates
- Two orders of magnitude improvement in Naval Observatory primary clock

1997 – Phillips
2001 – Kettlerle / Wieman / Cornell
2005 – Hall
2012 – Wineland





Global Positioning Systems (GPS):
The origin of GPS began in 1960 when the Navy launched the Transit satellite constellation for submarine navigation. Today's GPS systems are possible because of ONR sponsored research in precision timekeeping. ONR funding currently sustains the atomic clock industrial base in U.S.

Today

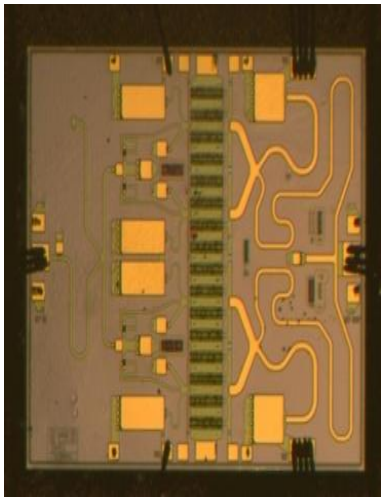
ONR research produced "Wide Bandgap Semiconductors"

- Led to compact, high power RF amplifiers for E-2D
- Is enabling development for high frequency, power amplifiers for Nulka and SEWIP

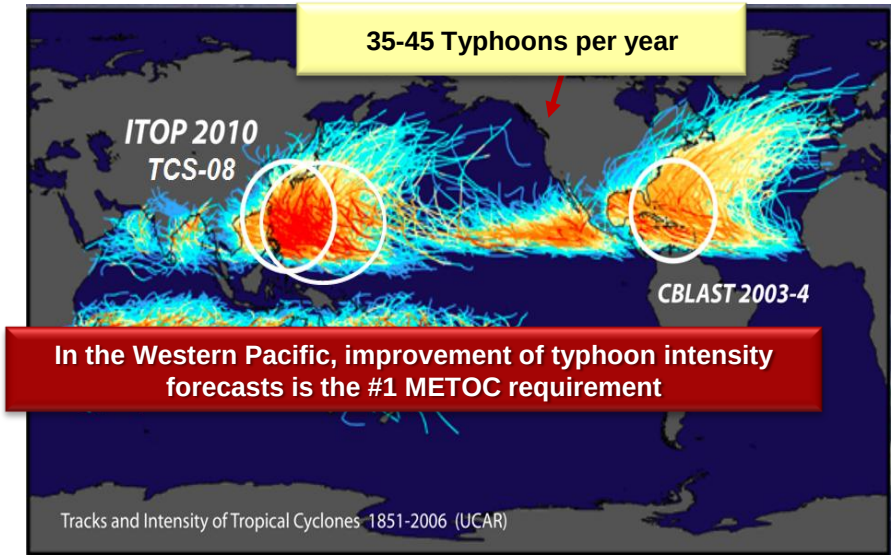
GaN & SiC Components—

ONR funded basic research on Si & GaN components led to the development of the wide bandgap semiconductors.

Breakthrough technology necessary to meet performance parameters within the space and weight constraints of the E-2D surveillance system design specification.



Tropical Cyclone Formation & Intensity Forecasts



Basic Research Efforts —

2004-2012

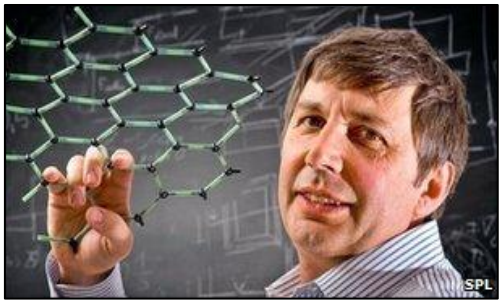
6.2 Transition: Enhance the Coupled Atmosphere-Wave-Ocean Model for Operational Evaluation.

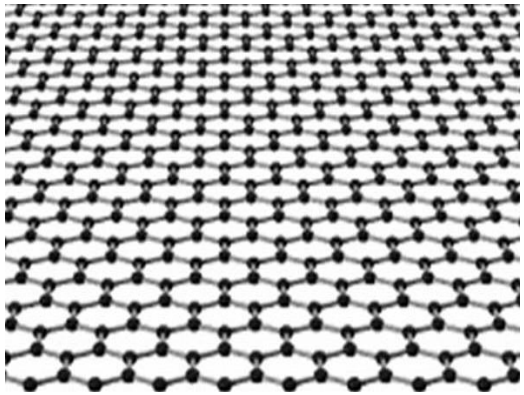
2009-2012

Joint 6.2/6.4 Rapid Transition Program: Collaborate with operational centers to transition research model to full operational status in 3 years for all typhoon, cyclone, and hurricane forecasts for global Fleet support.

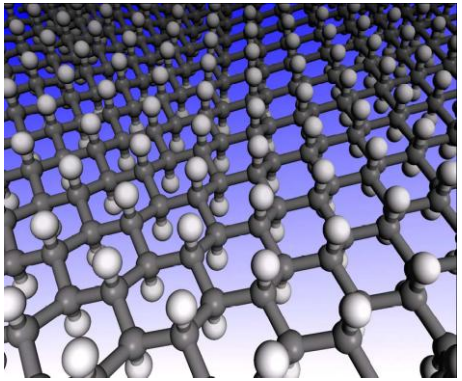
Tomorrow

Dr. Andre Geim
Langworthy & Royal Society Research Professor University of Manchester





GRAPHENE (Single-layer 2D Carbon)



GRAPHANE (Single-layer 2D Hydro-Carbon)

New ways of constructing 2D Electron Devices and Circuits

<u>Graphene - Graphane</u>

Graphane, a chemical derivative of Graphene

- Formed by attaching a hydrogen atom to each of the carbon atoms in the original graphene sheet
- Hydrogen alternates between above and below the sheet

Graphene and Graphane have drastically different electronic properties

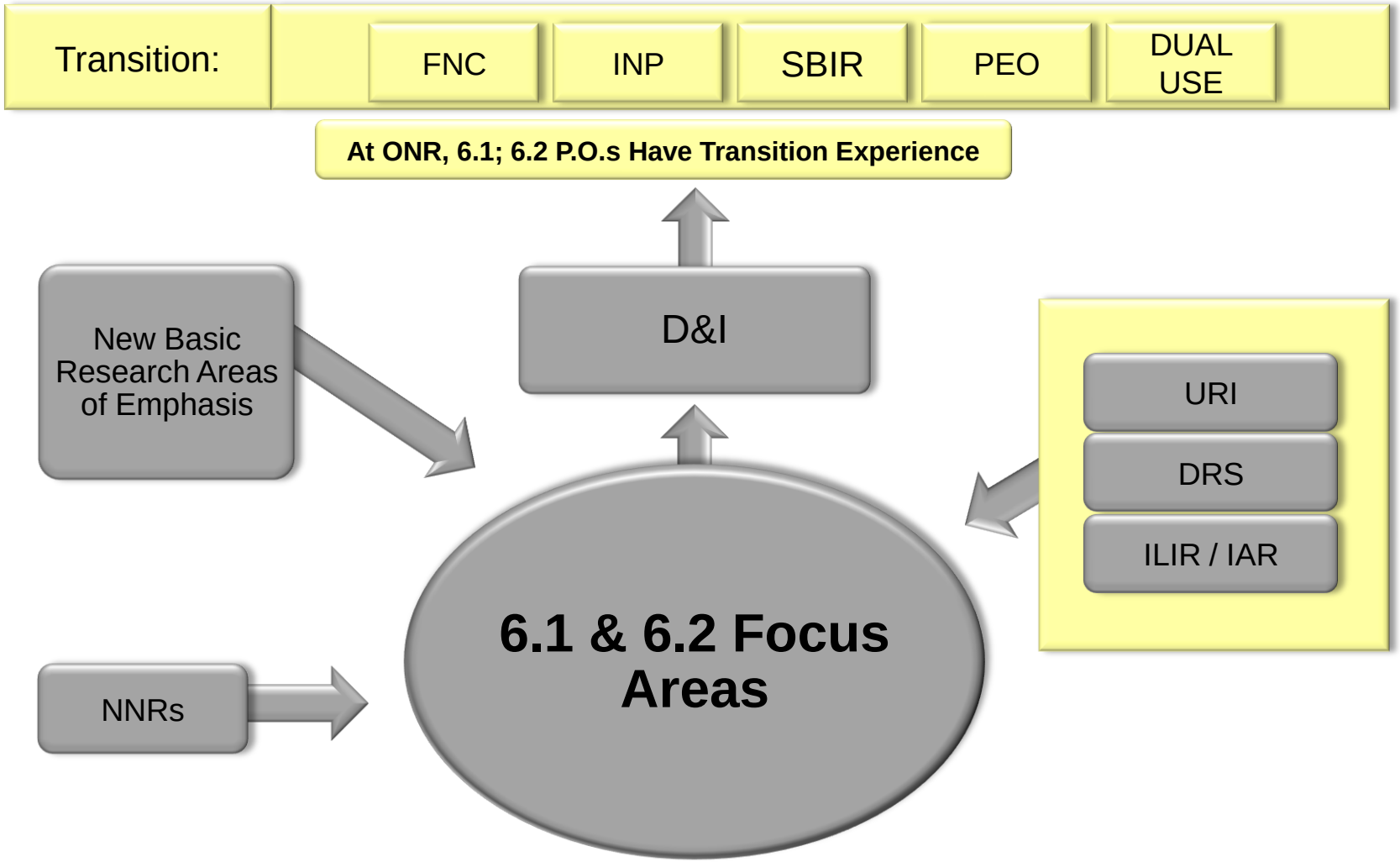
- Graphene is the best conductor known to man (at room temperature)
- Graphane is an electrical insulator

Graphene-Graphane reaction is entirely reversible

ONR Researchers, Geim & Novoselov, Awarded 2010 Nobel Prize in Physics

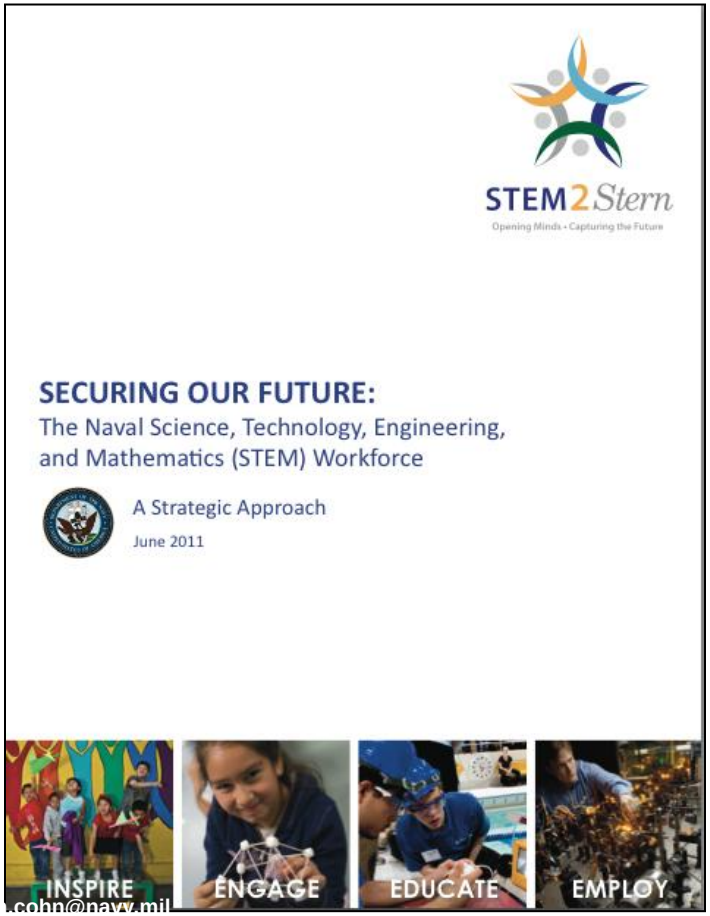
- ONR first in US to fund basic research; initial work general in nature, e.g. entire circuit perspective
- ONR & AFOSR work closely via the MURI process
- DARPA exploring RF applications

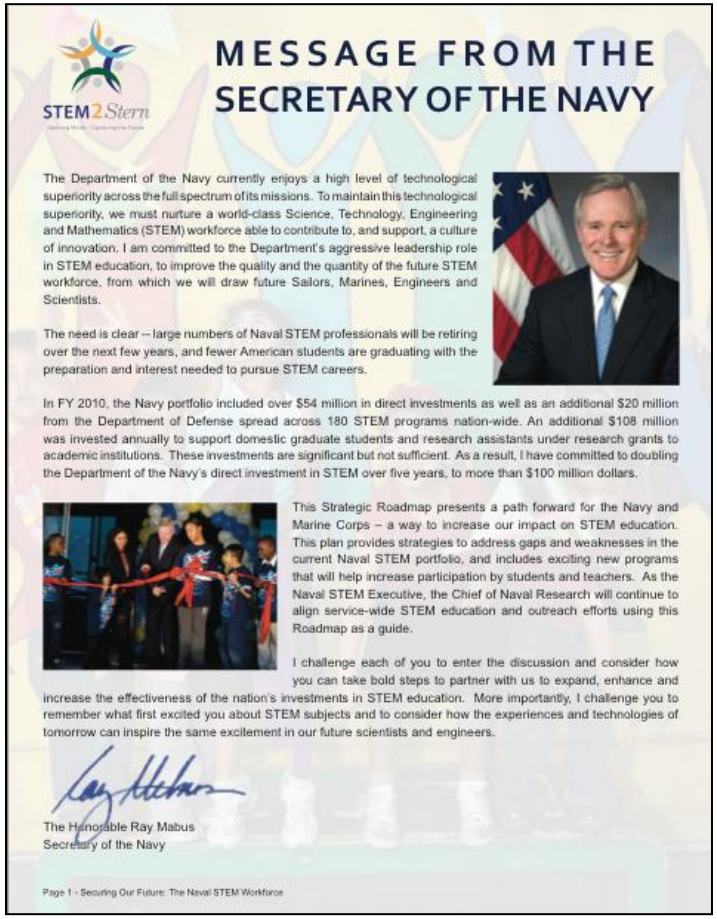
Transition of D&I



Science, Technology, Engineering, & Mathematics (STEM)

"…The need is clear – <u>large numbers of Naval STEM professionals will be retiring</u> over the next few years, and <u>fewer American students are graduating</u> with the preparation and interest needed to pursue STEM careers... " – SECNAV 2011





STEM Landscape

$18.3 M	$50.4 M	$14.9 M
Elementary, Middle, High School	Undergraduate, Masters, PhD	Faculty Research, Teacher Training & Professional Development

Programs

Elementary	Middle	High School	Undergraduate	Masters	PhD	Faculty Research, Teacher Training & Professional Development
Underrepresented Family Science Science Fairs iApps	Internships Digital Tutors Robotics Camps		Internships Scholarships Competitions Cohorts	Internships Scholarships Fellowships	Scholarships Fellowships	Young Investigator Summer faculty

Levers

- Fun
- Interesting
- Hands-on
- Real-world
- Family Involvement
- Use of Near-Peers

- Exciting / Relevant
- Competition
- Mentoring
- Social Networking
- Funding / Support
- Real-world Experience

- Employment/Stability
- Prestige
- Relevance
- Compelling Research
- Opportunity to Publish

Metrics

Inspire → Engage → Educate → Employ

Revolutionary Research . . . Relevant Results

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Questions to consider…

How much "Discovery and Invention" funding does Industry receive?

How large is a typical D&I program?

Who selects the programs? How do I meet them?

Where does ONR tell people what they want to fund?

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